

Impact of observations in the Southern Polar Area during the Concordiasi field experiment

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ECMWF

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NASA/GMAO

R. Langland

NRL

A. Cress

DWD

The Concordiasi experiment

Concordiasi = CONCORDIA-IASI

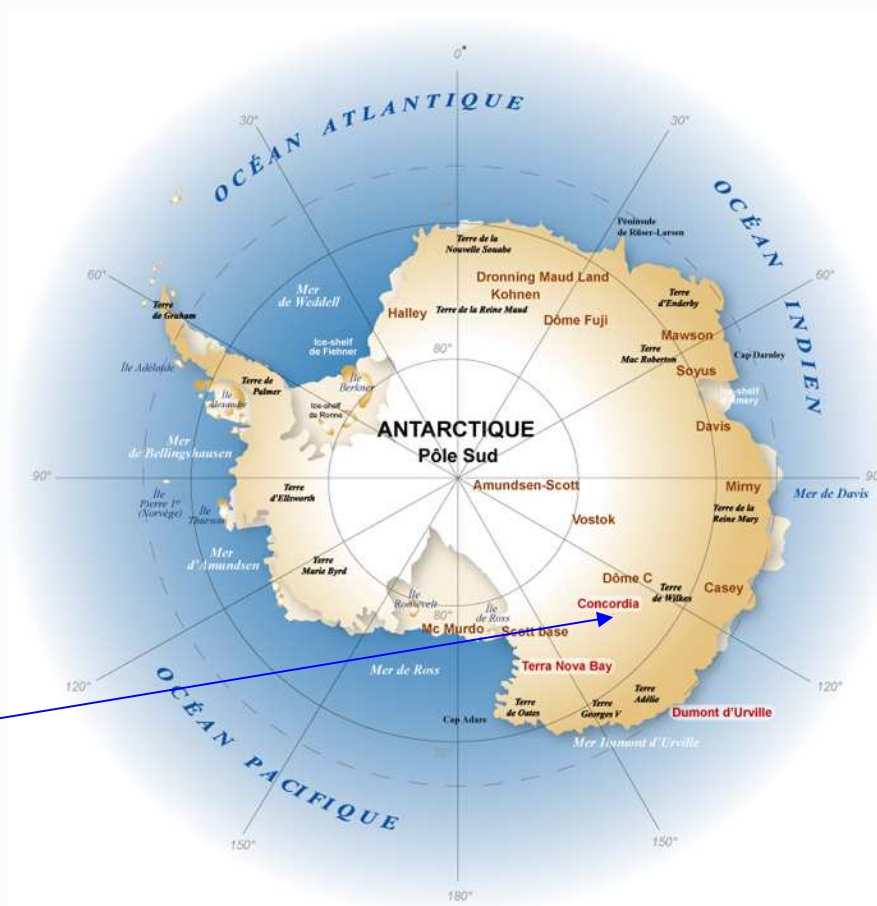
A French-US initiative for climate / meteorology over Antarctica



Improve the use of space-borne atmospheric sounders over polar regions, in particular IASI on board MetOp

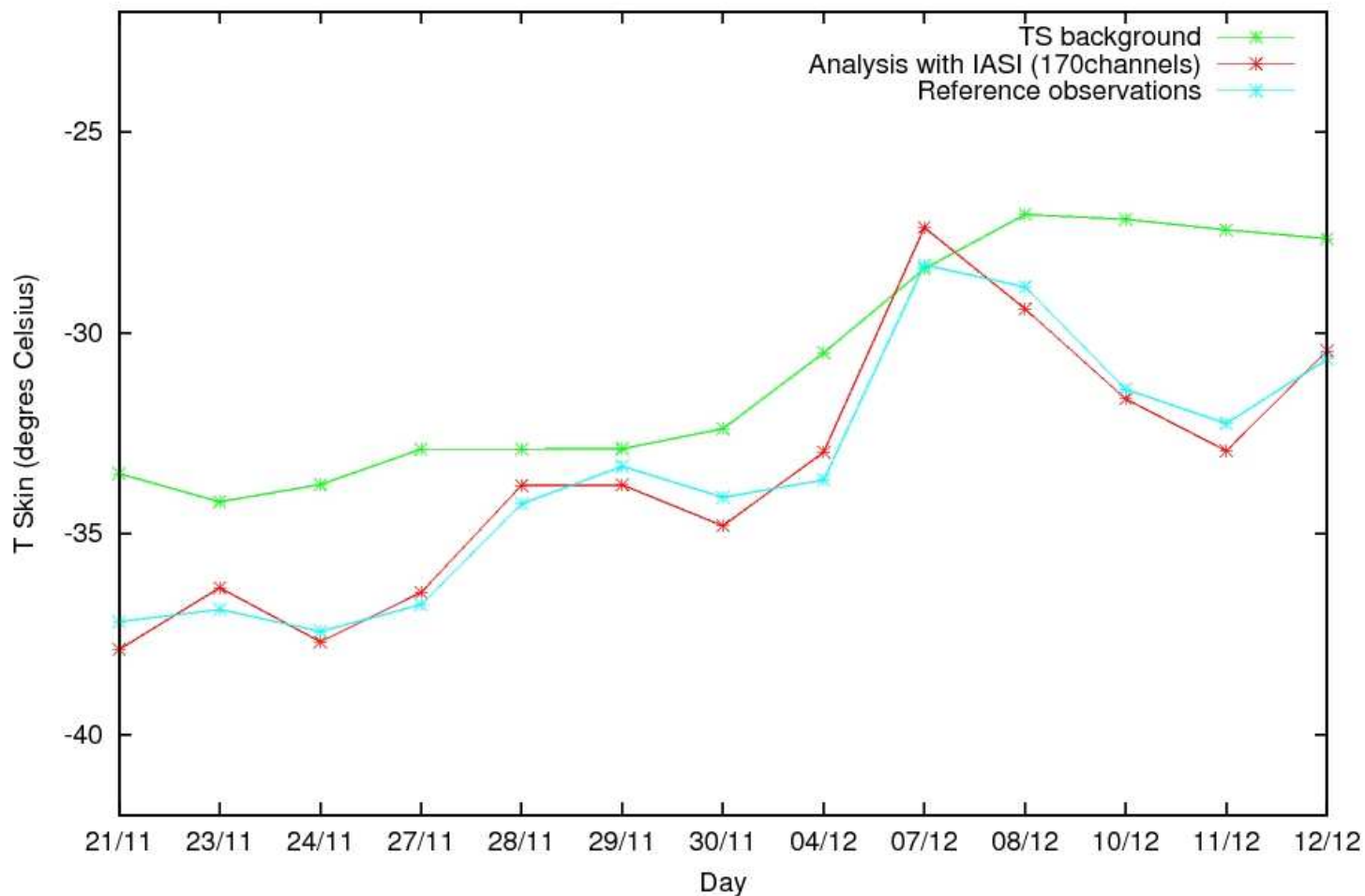
Benefit from the continental French-Italian station

Concordia



IASI retrievals at Concordia

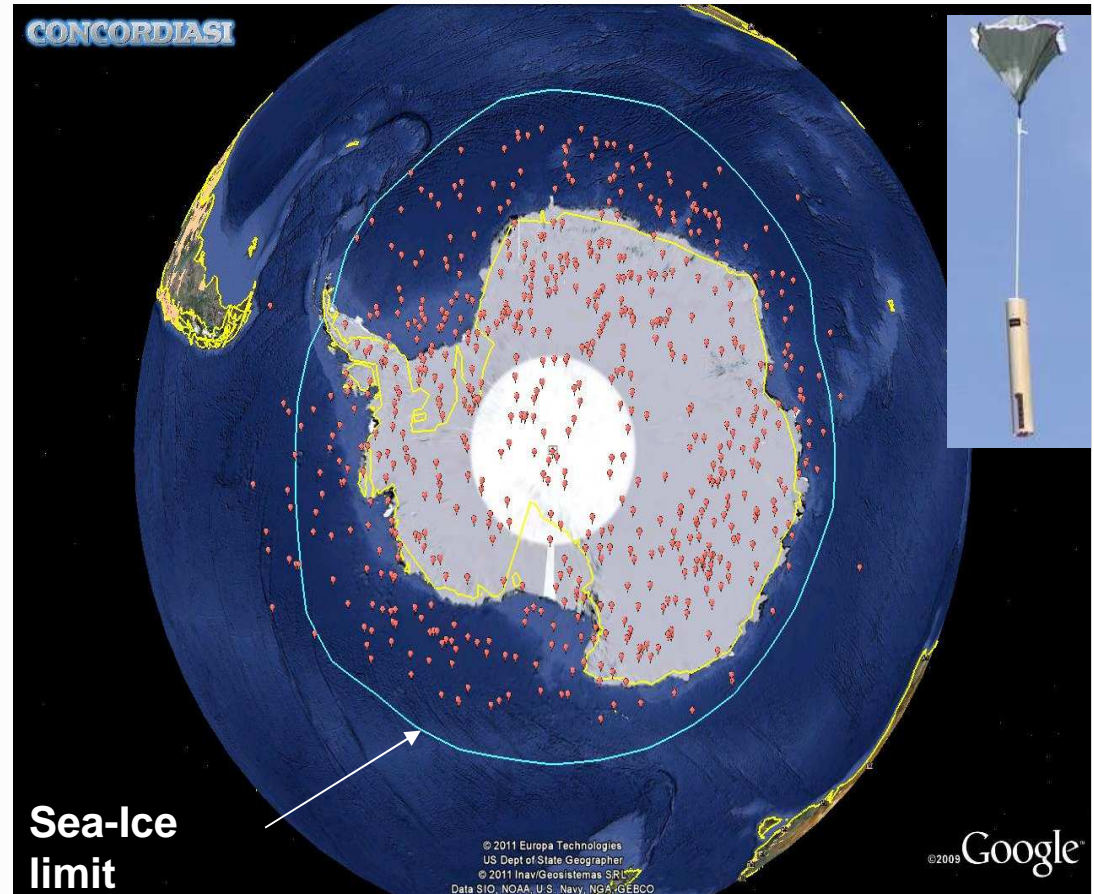
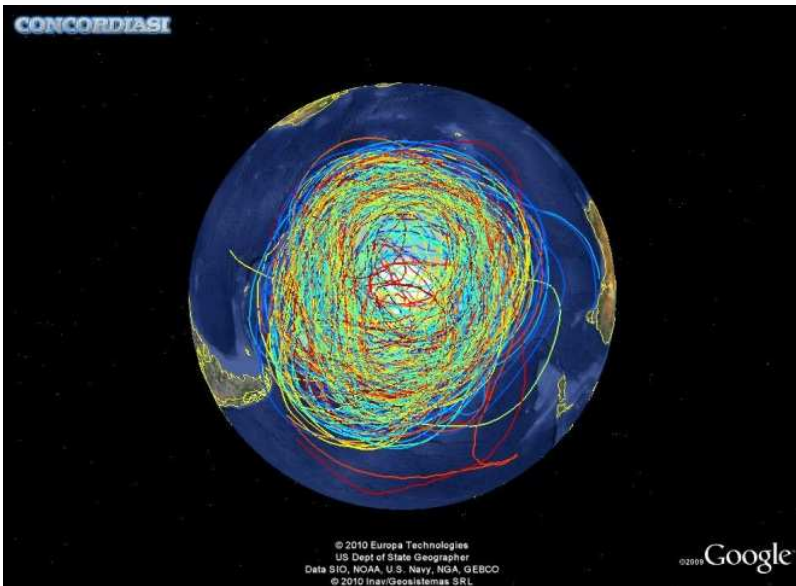
Temporal variation of T_{Skin} - clear cases November and december 2009



Good agreement of retrievals for Skin Temperature, compared to in situ data

(BSRN, manual measurements)

640 Dropsondes (20100923-20101201)



13 driftsondes launched

Flight-level data and dropsonde observations on GTS

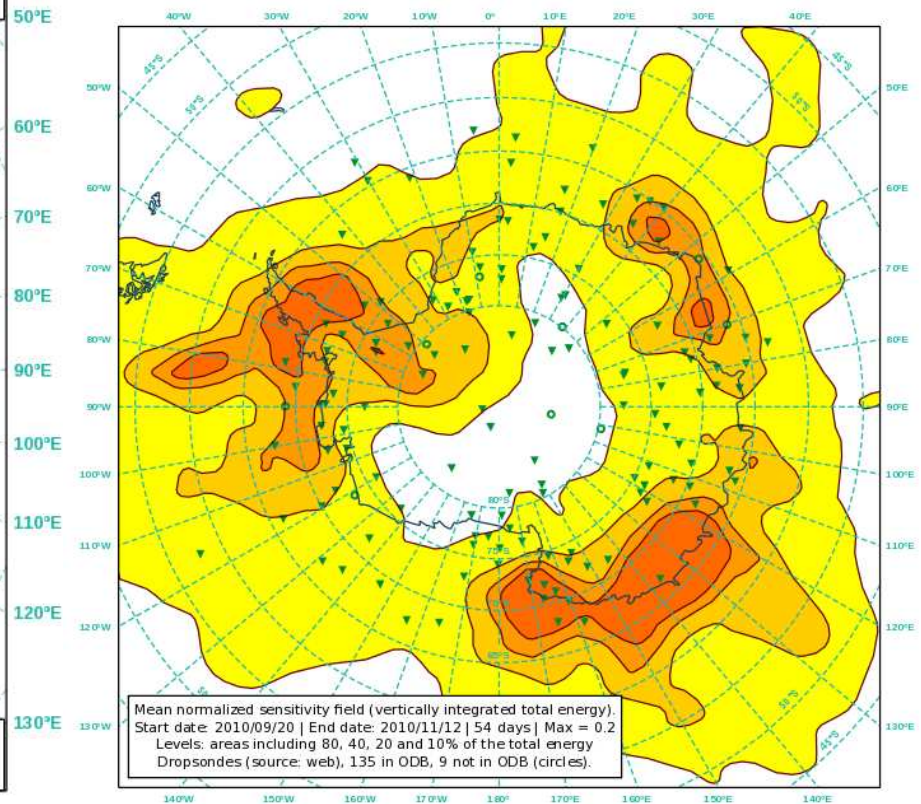
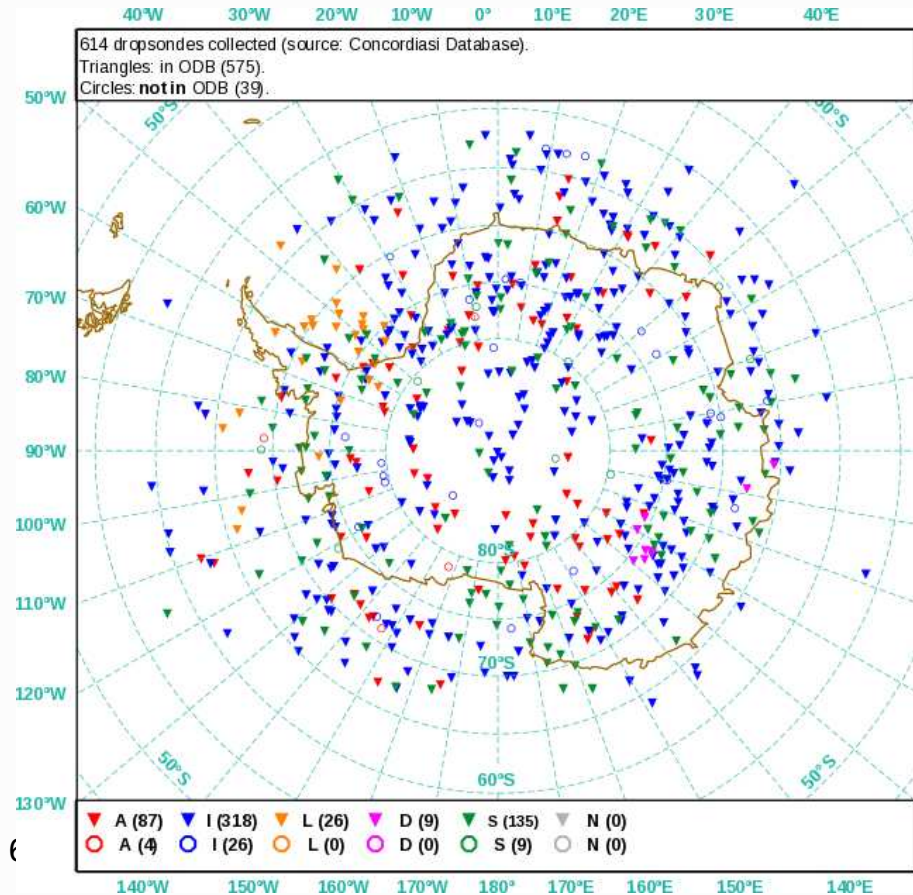
Dropsondes to calibrate the assimilation

Most of the sondes are dropped when coinciding MetOp overpasses + A-train

Part of the dropsondes are deployed in sensitive areas

Some in the Weddell Sea or near Concordia

Sensitive areas





Model uncertainty in the Southern Polar Area

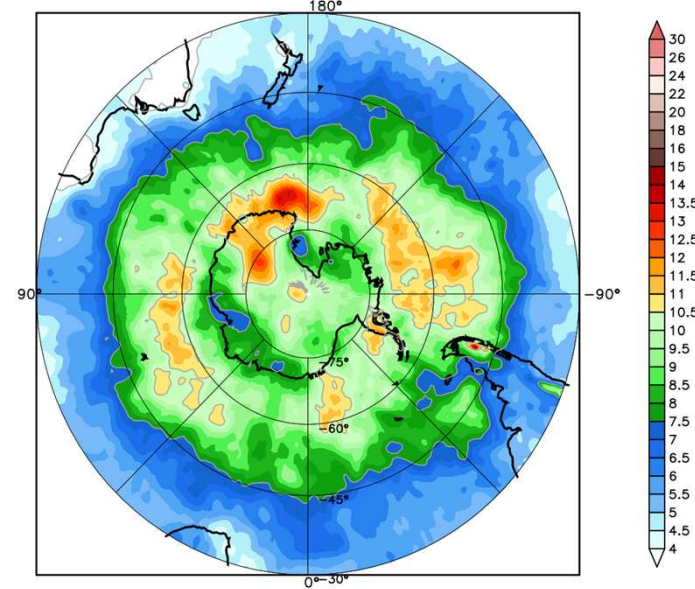
The Ring of Uncertainty 45°S to 70°S

To the north: Geostationary satellite winds, ship surface obs, commercial aircraft routes

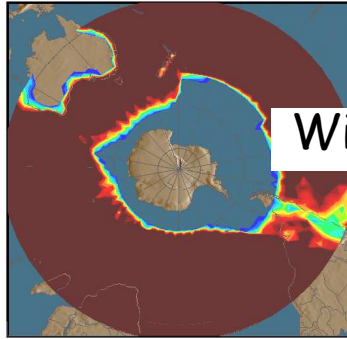
To the south: Antarctic raobs and land surface data, MODIS and AVHRR winds

Analyses differences

ECMWF | GFS
2010 -- 500 hPa Geopotential Height

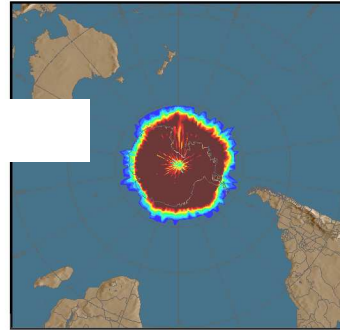


Sfc-10 hPa No. Sat Wind Obs 505286
24 of 30-Day ALL SSEC, ALL CHAN, VT 2011082000-201109

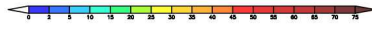


Winds

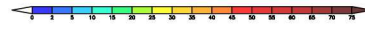
Sfc-10 hPa No. Sat Wind Obs 153848
24 of 30-Day ALL MODIS, ALL CHAN, VT 2011082000-2011091800



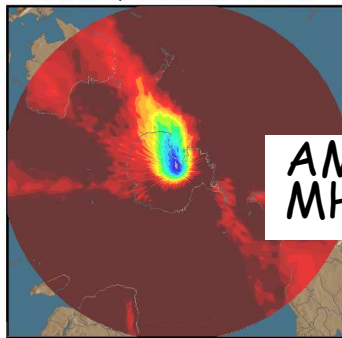
NOGAPS NAVDAS-AR



NOGAPS NAVDAS-AR

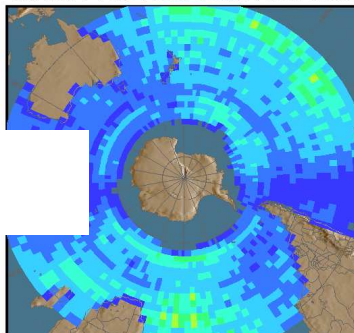


No. AMSU Obs 3.50306e+06
All NOAA, All Chan Min, Max: 0, 1915, Mean: 805.302, SDEV: 24 of 30-Day VT 2011082000-2011091800

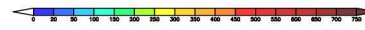


AMSU/
MHS

All Satellites, All Chan No. MHS Obs 133108
25 of 30-Day VT 2011090500-2011100500



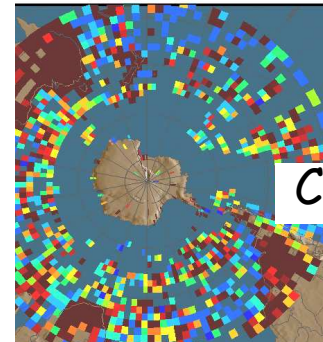
NOGAPS NAVDAS-AR



NOGAPS NAVDAS-AR

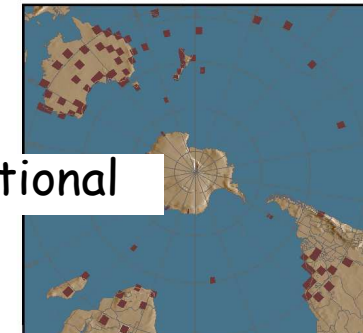


No. All Surface Obs 146738
-Day All Surface, VT 2011082000-2011091800



Conventional

Sfc-10 hPa No. All Radiosonde Obs 346809
24 of 30-Day Mandatory & Significant Levels, VT 2011082000-2011091800

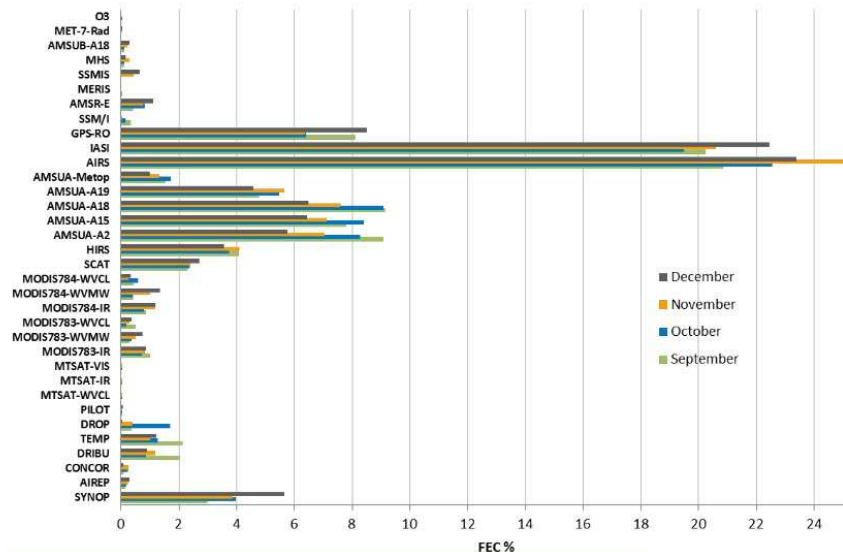
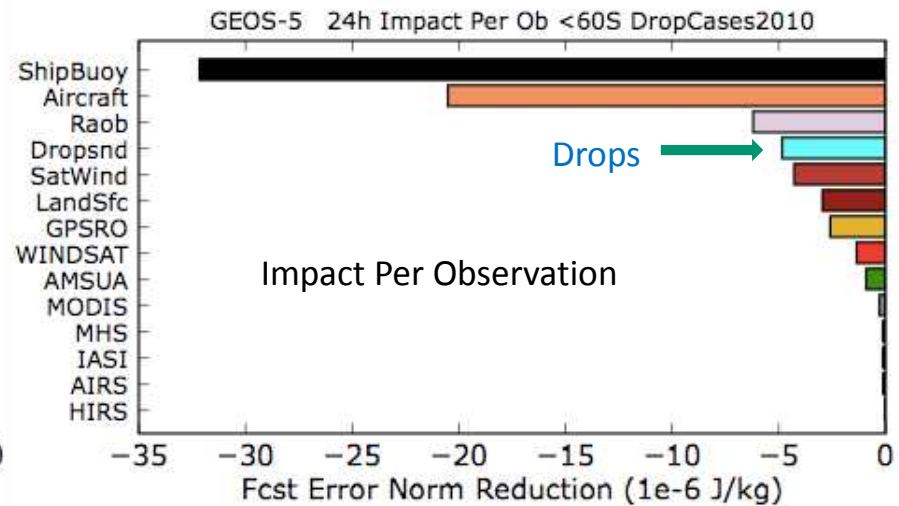
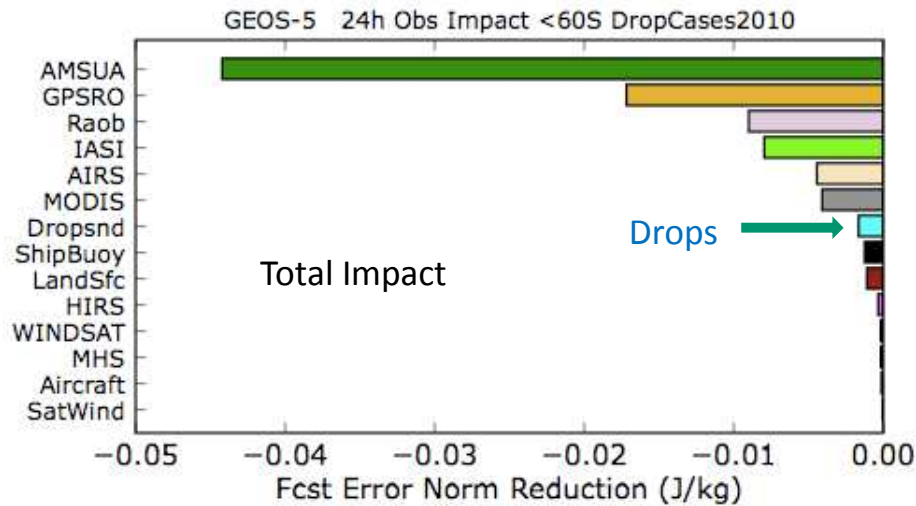


NOGAPS NAVDAS-AR

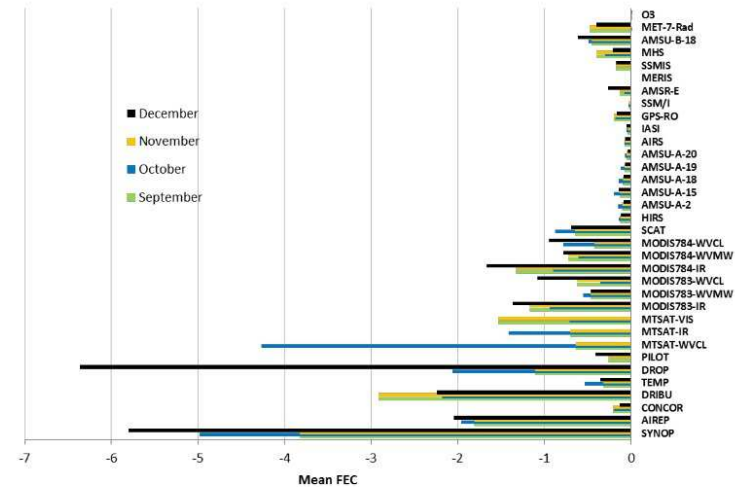


Impact of observations

GEOS-5 and ECMWF Observation Impacts for Concordiasi Average for All Drop Cases - 60°S-90°S Observations

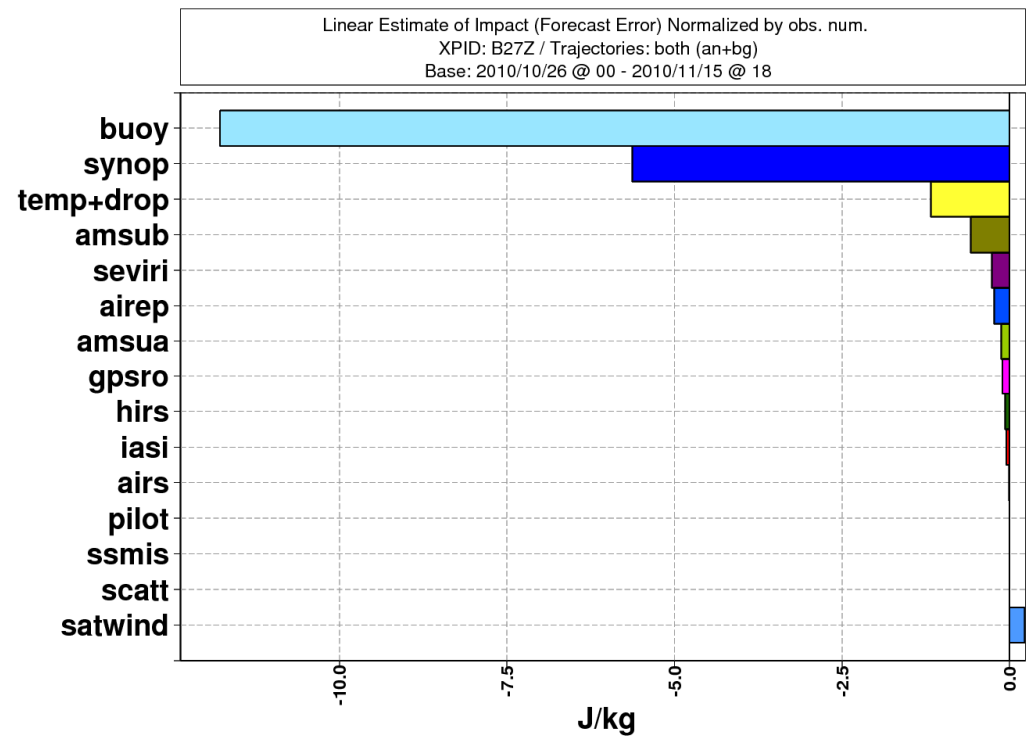
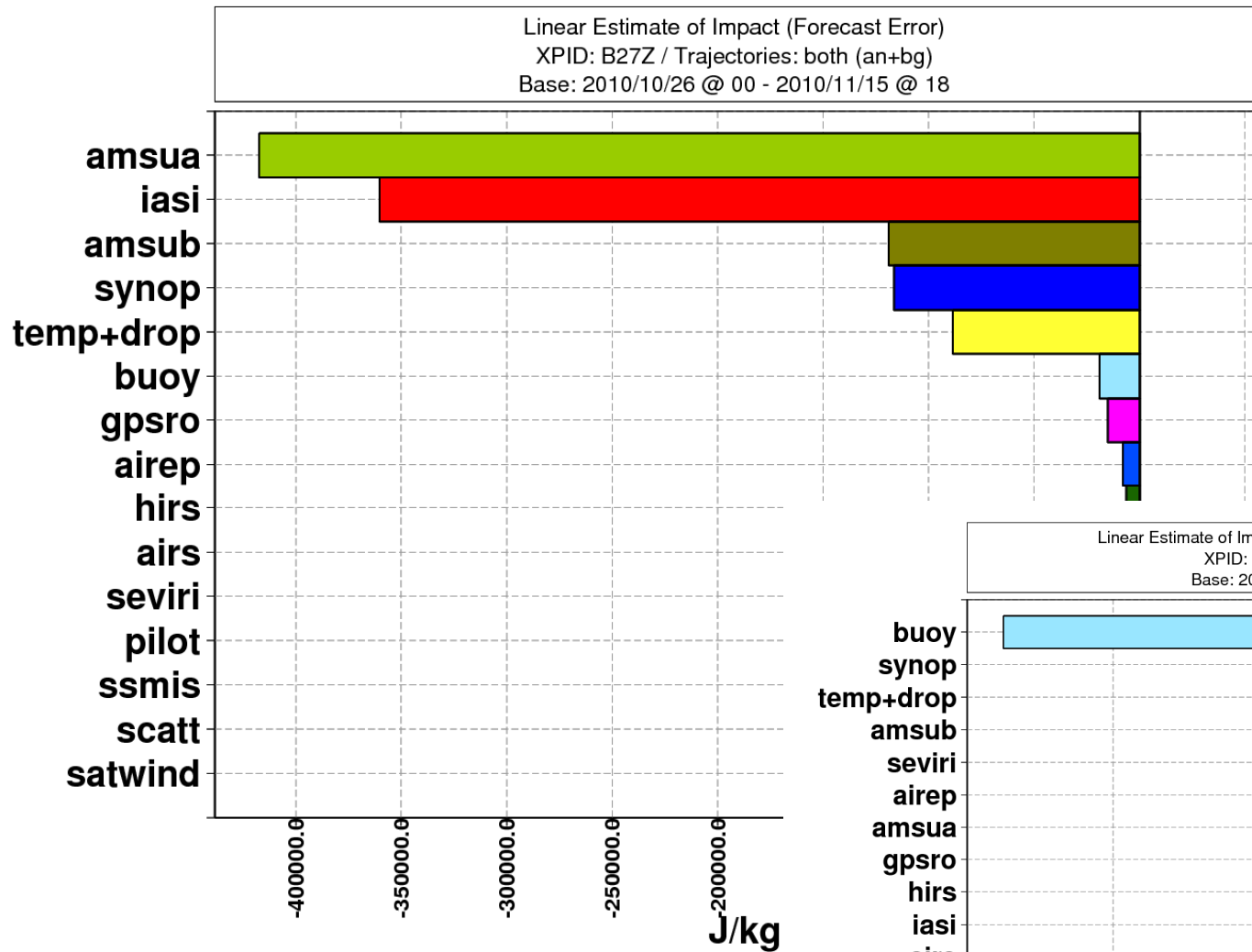


J: forecast error south of 60S



Same as previous but normalised by number of observations

At Meteo-France (obs south of 60 S)



Larger impact of
 AMSU-B/MHS,
 used over sea-ice

Observation impact in Navy Global Model with 4d-Var

Ob Impact results for Concordiasi

October 2010 (124 analyses and forecasts)

NOGAPS-NAVDAS_AR (4d-Var) operational forecast system
 Observation Impact on 24hr forecast error norm (total moist energy)
 For observations in geographic domain south of 60°S

Observation Type	Summed Impact J kg ⁻¹	Impact per-ob x10 ⁻⁵ J kg ⁻¹	Number Obs
Radiosondes	-2.8260	-3.2050	88,175
Dropsondes	-1.0658	-2.8050	37,996
GeoSat Wind	-0.0474	-0.7895	6,004
MODIS Wind	-10.4172	-1.3243	786,618
AVHRR Wind	-2.6195	-0.6724	389,562
LEO – GEO Wind	-	-	-
AIREP	-0.0001	-0.0342	292
AMDAR	-0.0793	-11.1690	710
LAND SFC	-2.0729	-1.9161	108,185
SHIP SFC	-0.2345	-4.6704	5,021
SSMI SFC WIND	+0.0327	+0.1189	27,493
SCAT SFC WIND	+0.0082	+0.6193	1,324
ASCAT SFC WIND	-0.1490	-1.5351	9,706
WINDSAT SFC WIND	-0.0403	-1.0172	3,962
SSMI TPW	-0.0112	Profiles	11,902
WINDSAT TPW	-0.0012	Profiles	633
GPS-RO	-2.1002	-0.1394	1,507,041
AMSU-A	-8.3132	-0.2088	3,981,468
IASI	-3.8546	-0.0650	5,932,979
SSMIS	-3.4714	-0.0909	3,820,906
AQUA	-0.5572	-0.4474	124,553
Total	-37.8201	-0.2329	16,844,530

Ob Impact results for Concordiasi

November 2010 (120 analyses and forecasts)

NOGAPS-NAVDAS_AR (4d-Var) operational forecast system
 Observation Impact on 24hr forecast error norm (total moist energy)
 For observations in geographic domain south of 60°S

Observation Type	Summed Impact J kg ⁻¹	Impact per-ob x10 ⁻⁵ J kg ⁻¹	Number Obs
Radiosondes	-4.1576	-4.3059	96,555
Dropsondes	-0.3897	-2.3548	16,549
GeoSat Wind	-0.0328	-0.4394	7,464
MODIS Wind	-9.8412	-1.4403	683,294
AVHRR Wind	-2.5080	-0.9163	273,714
LEO – GEO Wind	-2.2028	-1.7574	125,346
AIREP	-0.0074	-2.8030	264
AMDAR	-0.0420	-9.5890	438
LAND SFC	-2.6777	-2.5005	107,087
SHIP SFC	-0.2252	-5.0033	4,501
SSMI SFC WIND	+0.1045	+0.3066	34,079
SCAT SFC WIND	+0.0030	+0.3401	882
ASCAT SFC WIND	-0.1335	-0.9942	13,428
WINDSAT SFC WIND	-0.1210	-1.5430	7,842
SSMI TPW	-0.0246	Profiles	17,469
WINDSAT TPW	-0.0017	Profiles	1,361
GPS-RO	-2.5009	-0.2010	1,244,254
AMSU-A	-7.3740	-0.1659	4,445,345
IASI	-6.8671	-0.0912	7,527,142
SSMIS	-0.7657	-0.0168	4,563,291
AQUA	-0.3609	-0.2061	175,140
Total	-40.1263	-0.2079	19,345,445

Compiled by Rolf H. Langland
 NRL-Monterey

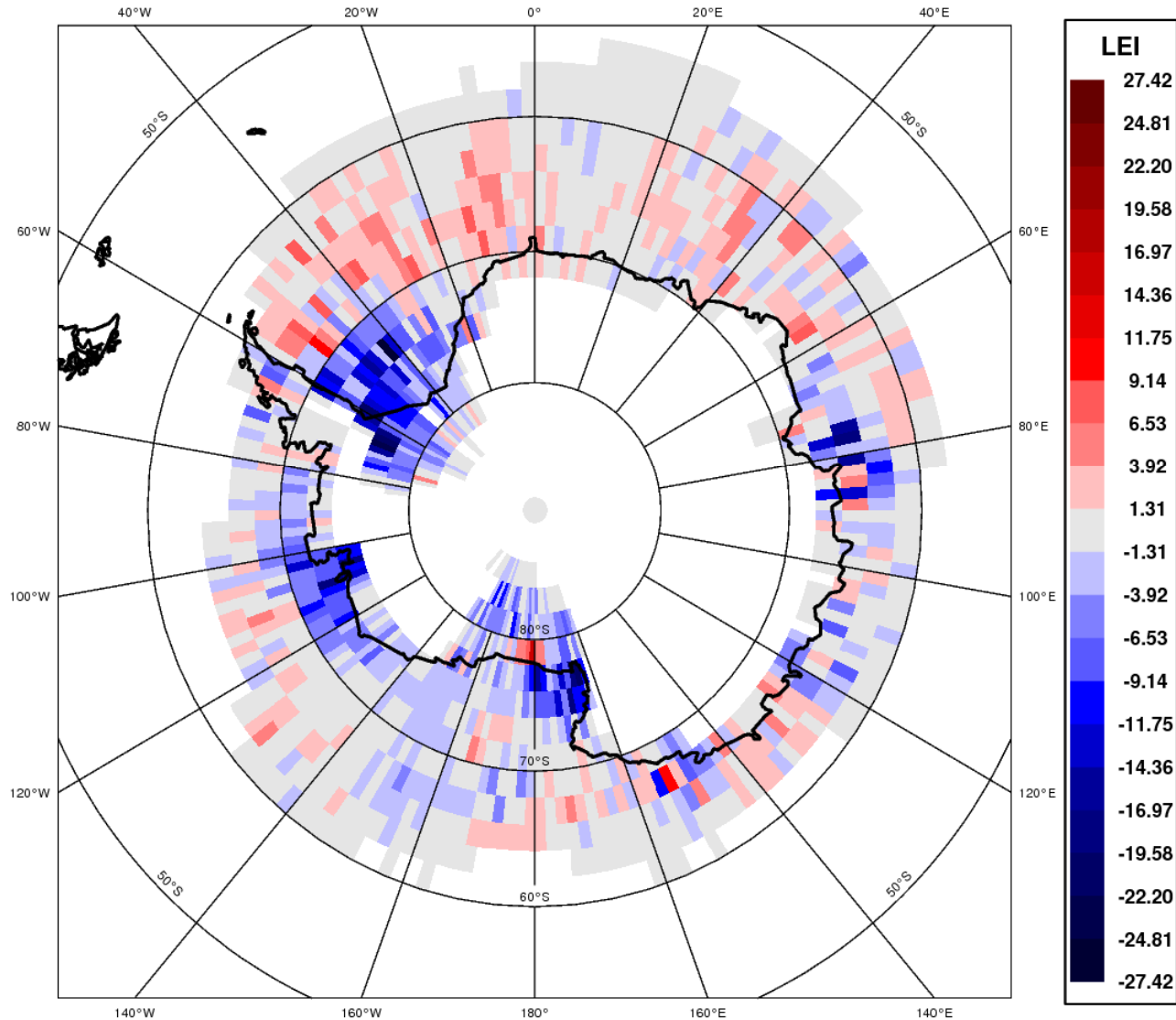
Compiled by Rolf H. Langland
 NRL-Monterey

Most important data types for different systems

	In decreasing order of importance
ECMWF	AIRS and IASI , AMSU-A , GPS-RO , MODIS , HIRS, Synop, RAOB, Buoy
NASA	AMSU-A , GPS-RO , IASI and AIRS , RAOB , MODIS, Buoy, Synop, HIRS
NRL	MODIS , AMSU-A , IASI , RAOB , Synop , AVHRR, GPS-RO, LEO-GEO
MF	AMSU-A , IASI and AIRS , AMSU-B , Synop , RAOB, Buoy, GPS-RO, HIRS

Large impact of AMSU-B over sea ice, used at Meteo-France

Averaged Linear Estimate of Impact (LEI): -1436.32 J/kg
Experiment: B27Z / From 2010/10/26 at 00UTC to 2010/11/15 at 18UTC / H UTC cycles / Grid: 2° × 2°.
Objective function : Total energy of the 24h forecast error.
Observation type: amsub_seaice, channel: 9999, level : all



Fatima
Karbou

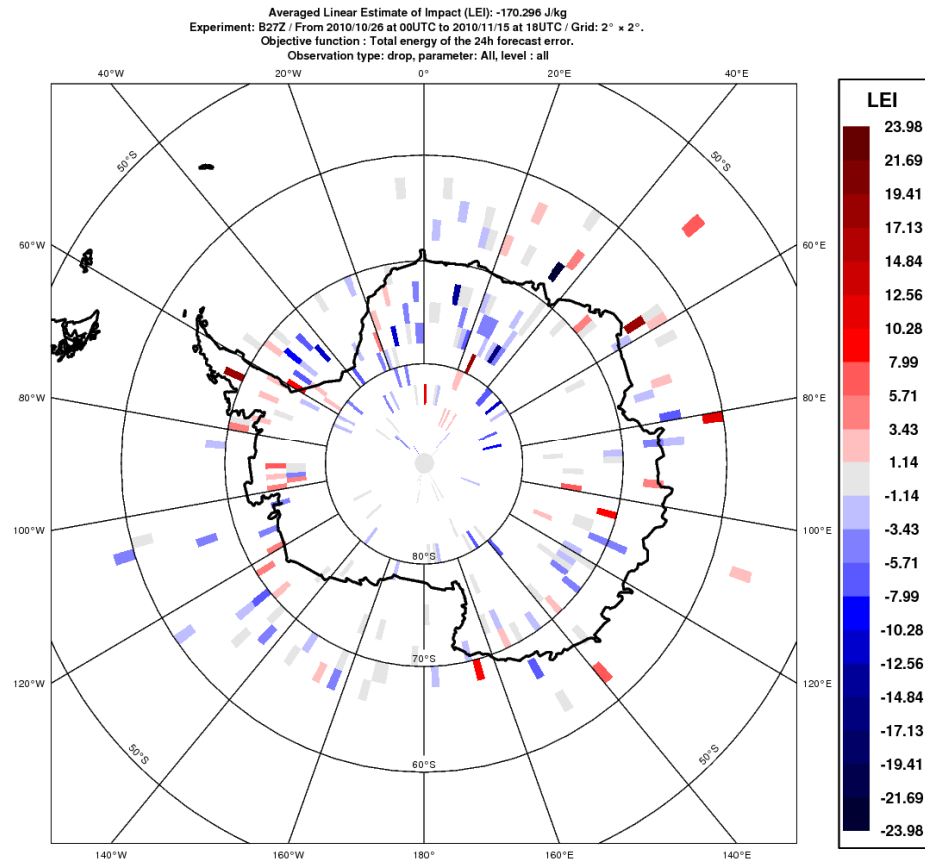
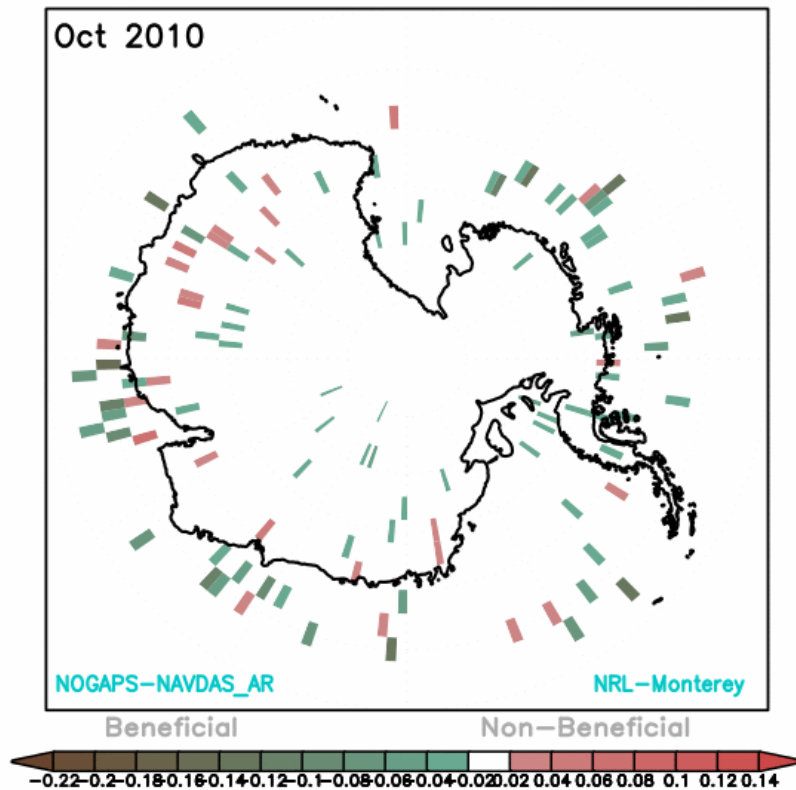
Impact of dropsondes

Sensitivity to dropsonde observations (NRL and MF)

Amount of dropsonde data deployed during part of Concordiasi
26 September - 30 November 2010
58,679 observation data (T, u, v, q)

Approximately the same amount of data provided by
three additional radiosonde stations with 00UTC and 12UTC daily
soundings

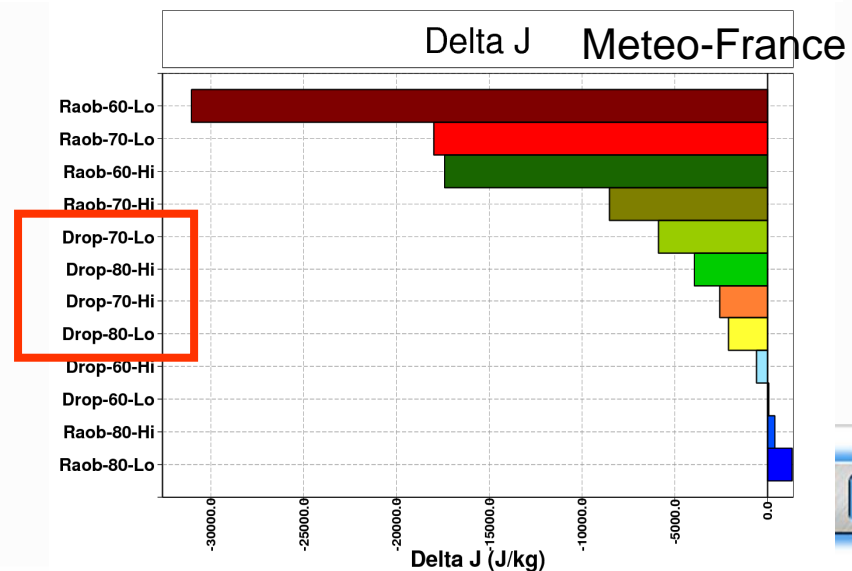
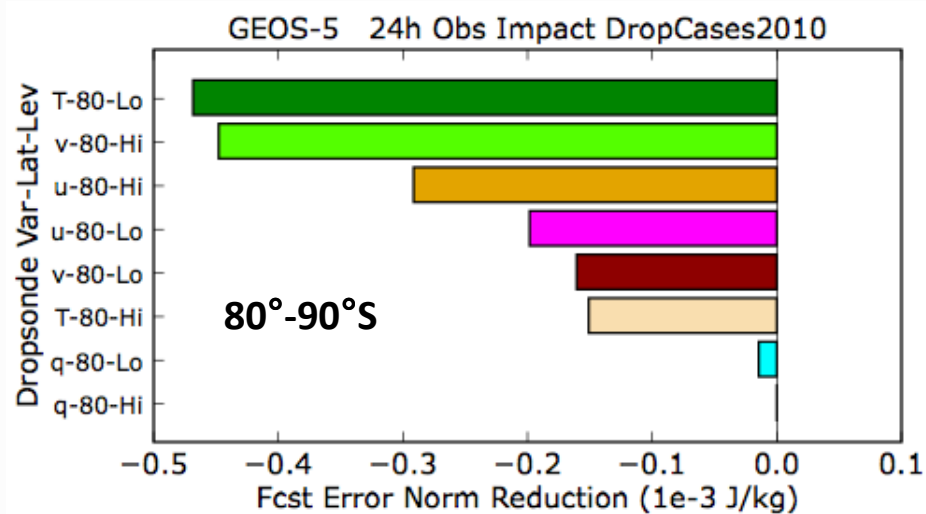
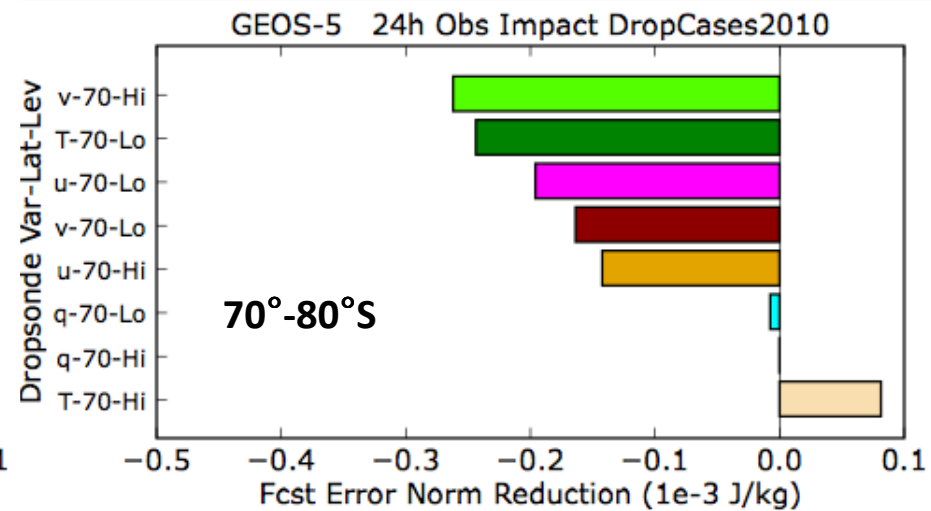
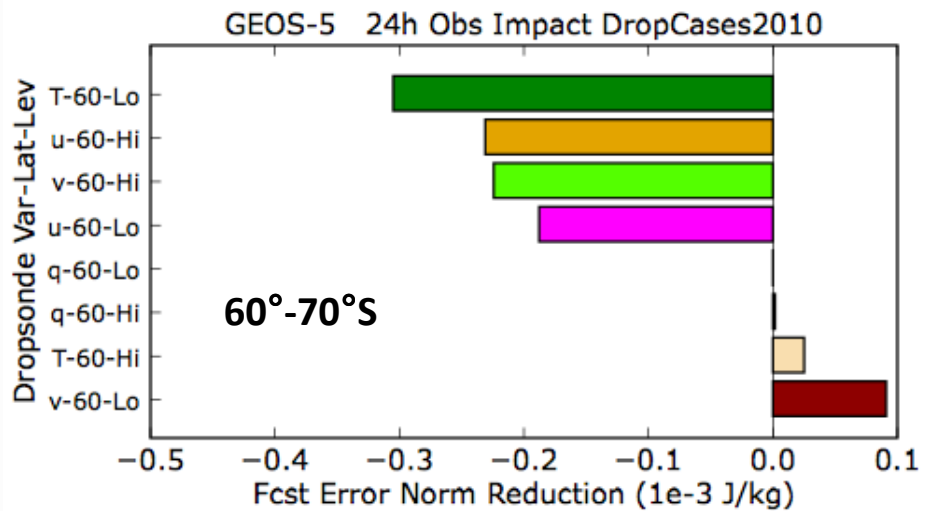
DROPSONDE Impact on 24h Fcst Error Norm



Observation Impacts for Concordiasi at GMAO and MF

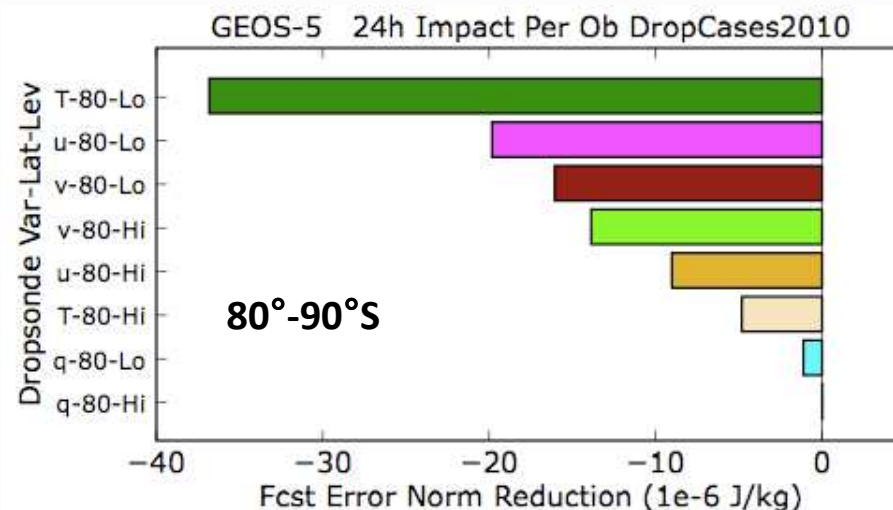
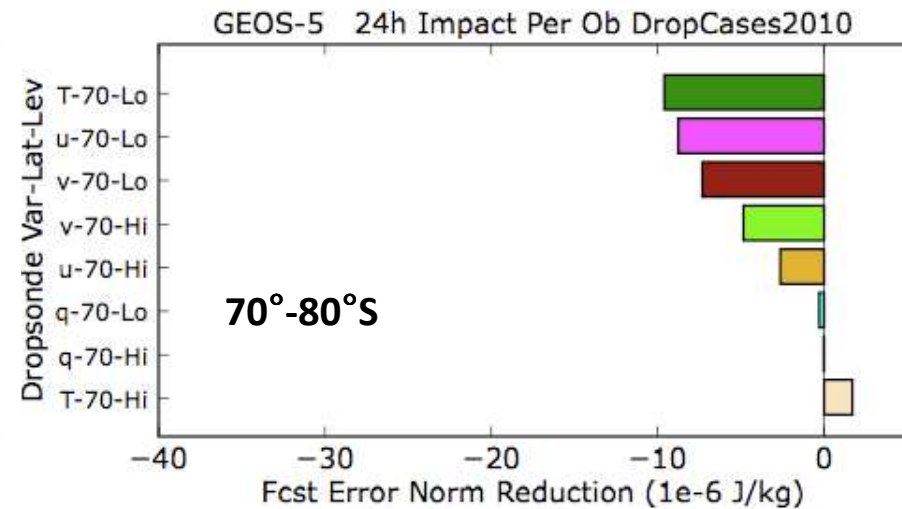
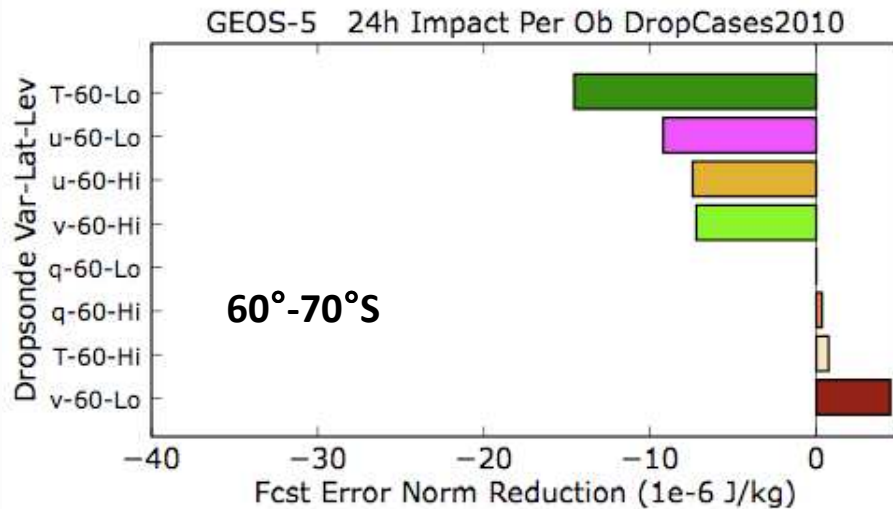
Dropsonde u,v,T,q - Averages for All Drop Cases

Dropsonde Observation Impact



GEOS-5 Observation Impacts for Concordiasi Dropsonde u,v,T,q - Averages for All Drop Cases

Impact Per-Observation



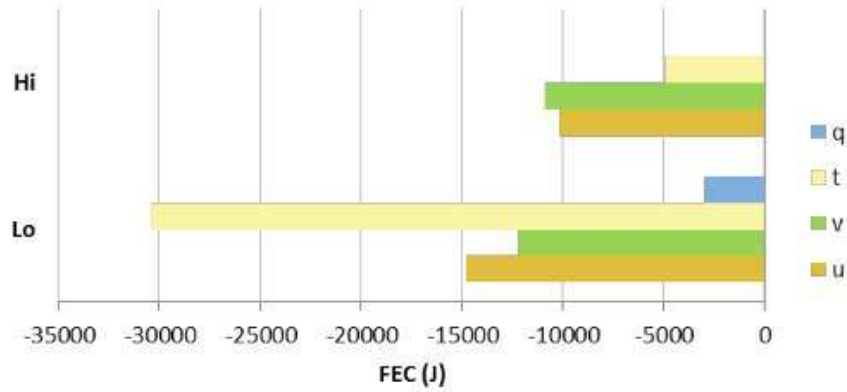
Larger impact at higher latitudes,

Over Antarctic plateau

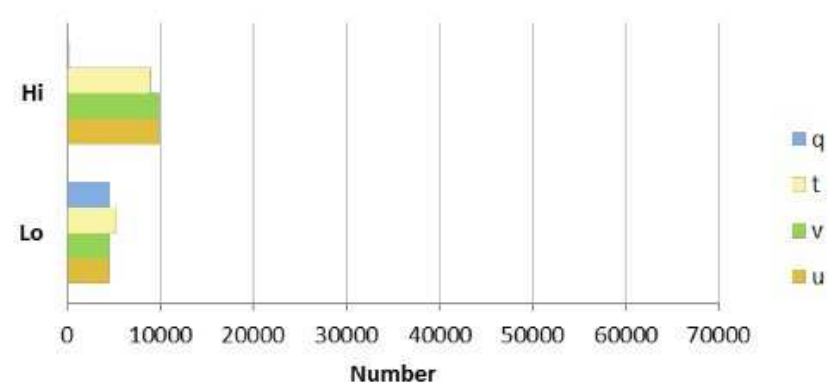
where less other data are assimilated

Dropsonde and Radiosonde impact Sep-Dec 2010 at ECMWF

Dropsonde



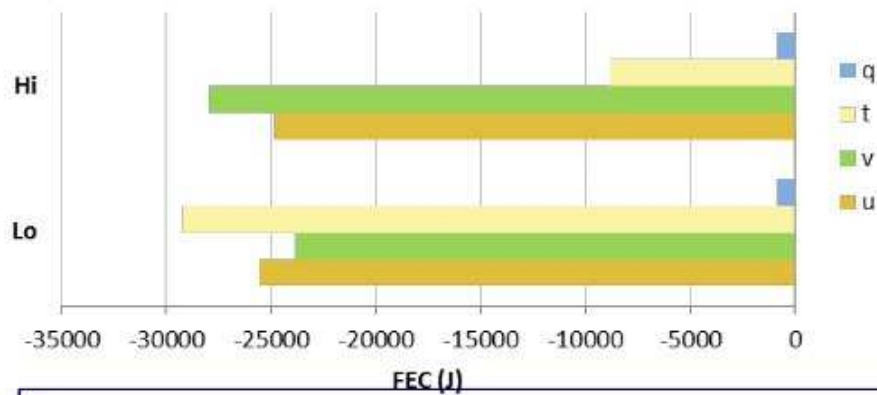
Dropsonde



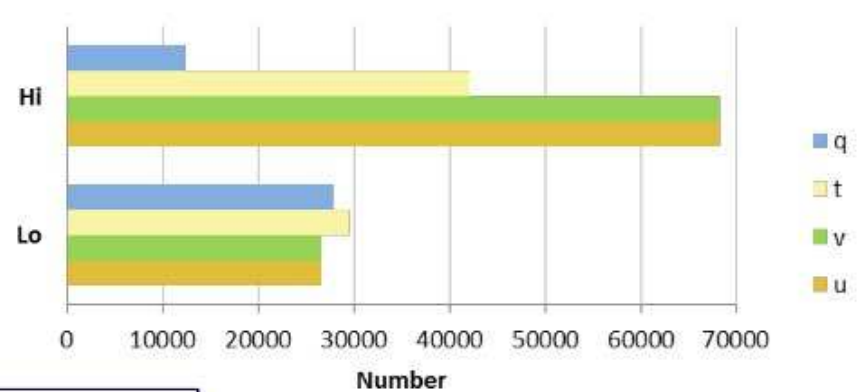
Hi: < 400 hPa

LO: > 400hPa

Radiosonde



Radiosonde

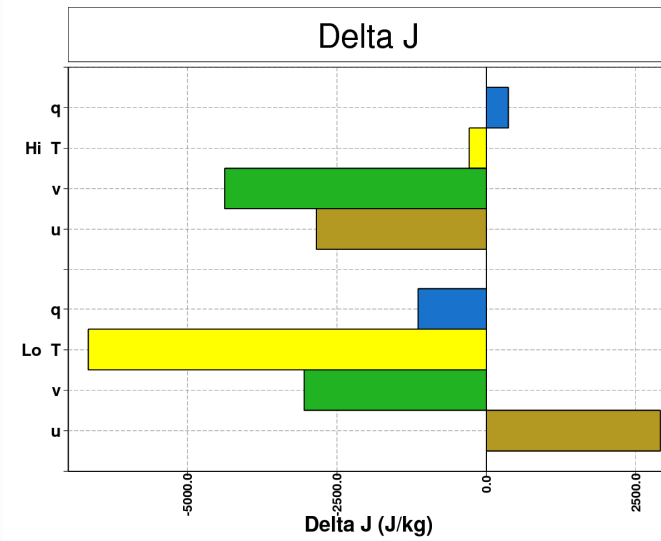


Hi: < 400 hPa

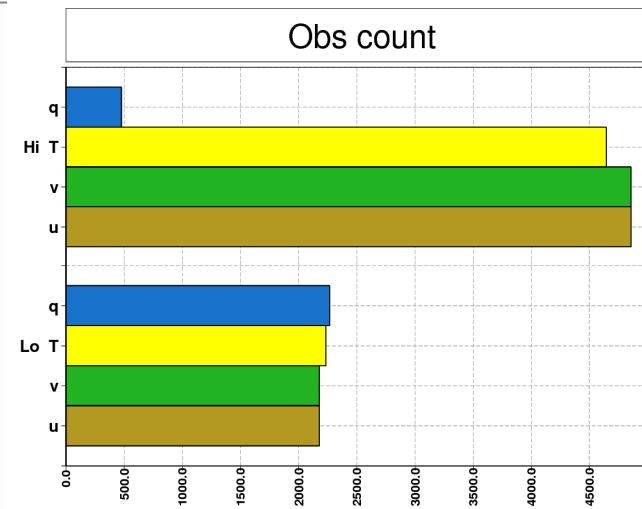
LO: > 400hPa

Dropsonde and Radiosonde impact Oct-Nov 2010 at Meteo-France

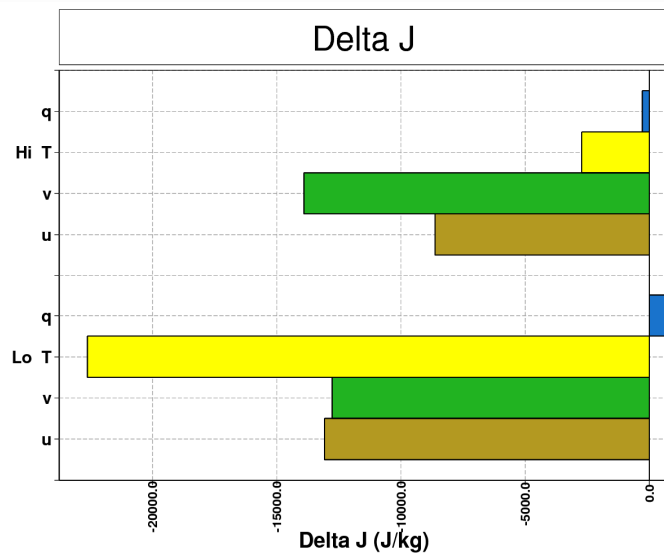
Dropsonde



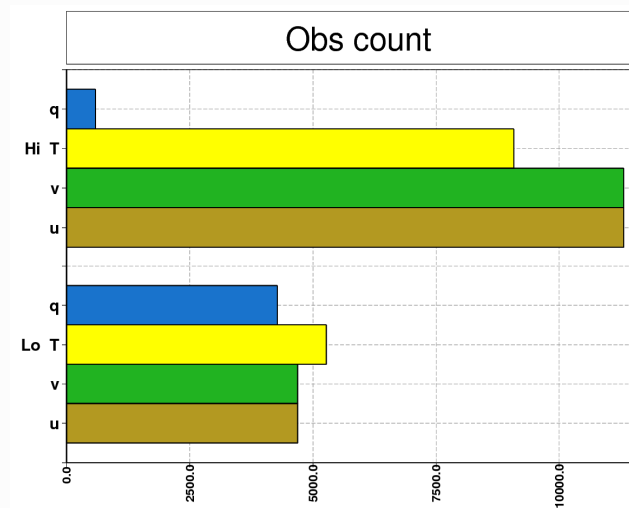
Dropsonde



Radiosonde



Radiosonde



Summary of dropsonde results

Larger impact at **higher latitudes**,

Over Antarctic plateau where less other data are assimilated

More impact from **winds at higher levels**

More impact from **temperature at lower levels**

OSEs

Assimilation of gondola information at DWD

TEMP Verification GME/7894

TIME: 2010091700 - 2010093012

OBS minus FG (full) OBS minus ANA (dotted) Used

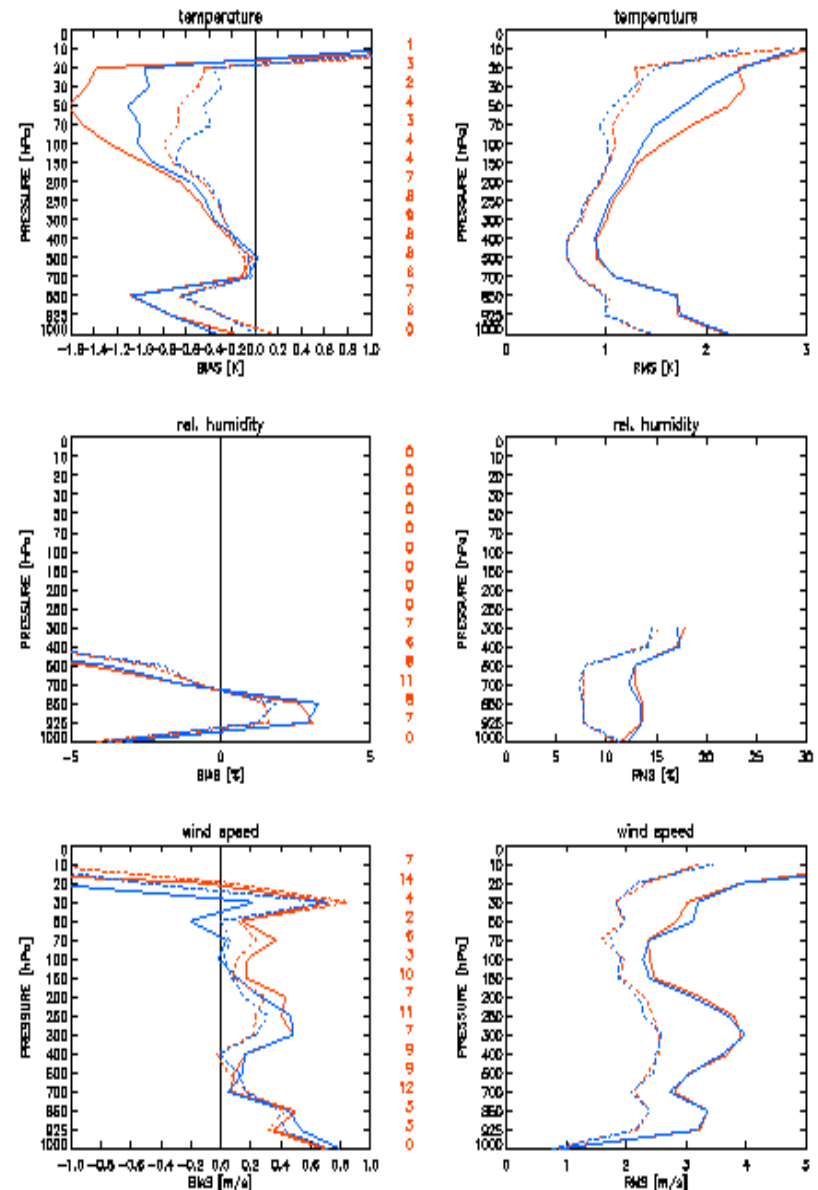
Radiosonde Verification

- Bias (left); RMS (right)
- Antarctic region
- Comparison of Routine (red) against Experiment using stratospheric balloon measurements (blue)

Results:

Temperature- and Windspeed bias reduced over Antarctica in the lower stratosphere

RMS of temperature is reduced considerably for both, OBS minus FG and OBS minus Ana



OSE at Météo-France: impact of both dropsonde and gondola information over 7 weeks

Significant impact in reduction of RMS(O-G)
wrt radiosondes over Antarctica

	Without	With
U 200hPa (m/s)	2.53	2.47
V 200 hPa	2.60	2.53
U 250 hPa	2.87	2.75
V 250 hPa	2.73	2.67
T 500 hPa (K)	1.03	1.01

Concluding remarks

Over the Southern polar area, large uncertainty in a ring 45-70S

Large impact of satellite data: AMSU-A, IASI and AIRS, GPS-RO

Non-negligible impact of conventional data

In some systems, large impact of AMSU-B/MHS over sea-ice,
large impact of MODIS winds

Potential large benefit of using IASI data down to surface
over Antarctica

Concluding remarks

Both Concordiasi dropsonde and gondola information have a positive impact on forecast performance

Dropsondes have a larger impact at high latitudes (inside Antarctic continent)

Large impact of wind observations at high levels, of temperature information at lower levels

Papers on Concordiasi so far...

Rabier, F., A. Bouchard, E. Brun, A. Doerenbecher, S. Guedj, V. Guidard, F. Karbou, V.-H. Peuch, L. E. Amraoui, D. Puech, C. Genthon, G. Picard, M. Town, A. Hertzog, F. Vial, P. Cocquerez, S. Cohn, T. Hock, H. Cole, J. Fox, D. Parsons, J. Powers, K. Romberg, J. VanAndel, T. Deshler, J. Mercer, J. Haase, L. Avallone, L. Kalnajsand, C. R. Mechoso, A. Tangborn, A. Pellegrini, Y. Frenot, A. McNally, J.-N. Thépaut, G. Balsamo and P. Steinle, 2010 : "The Concordiasi project in Antarctica" Bulletin of the American Meteorological Society. Bulletin of the American Meteorological Society, January 2010, 69-86.

Guedj S., F. Karbou, F. Rabier, A. Bouchard, 2010: Toward a better modelling of surface emissivity to improve AMSU data assimilation over Antarctica. IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, Vol. 48, NO. 4, 1976-1985.

Bouchard A, F. Rabier, V. Guidard & F. Karbou, 2010 : Enhancements of satellite data assimilation over Antarctica. MWR, June 2010, 138, 2149-2173.

Brun, E., D. Six, G. Picard, V. Vionnet, L. Arnaud, E. Bazile, A. Boone, A. Bouchard, C. Genthon, V. Guidard, P Le Moigne, F. Rabier, Y. Seity, 2011: Snow-atmosphere coupled simulation at Dome C, Antarctica. Journal of Glaciology. Vol. 52, No. 204, 2011

Vincensini, A., A. Bouchard, F. Rabier, V. Guidard, and N. Fourrié, 2011: IASI retrievals over Concordia within the framework of the Concordiasi programme in Antarctica. Accepted at IEEE- TGRS

Haase, J. S., J. Maldonado-Vargas, F. Rabier, P. Cocquerez, M. Minois, V. Guidard, P. Wyss, and A. V. Johnson (2012), A proof-of-concept balloon-borne Global Positioning System radio occultation profiling instrument for polar studies, Geophys. Res. Lett., 39, L02803, doi:10.1029/2011GL049982.

27 Genthon, C., M. S. Town, D. Six, V. Favier, S. Argentini, et A. Pellegrini, 2010. Meteorological atmospheric boundary layer measurements and ECMWF analyses during summer at Dome C, Antarctica, J. Geophys. Res., 115, D05104, doi:10.1029/2009JD012741